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## Risk Rating Guide for Mountain Pine Beetle in Black Hills Ponderosa Pine

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Average tree diameter, stand density, and stand structure are key elements used in the rating. Single-storied stands are most susceptible to heavy mountain pine beetle damage. Risk increases with d.b.h., reaching a maximum when trees are 12 inches d.b.h. and larger. During buildup of an outbreak, denser stands within a given mean diameter are more susceptible to invasion.

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Ponderosa pine stands in the Black Hills of South Dakota and Wyoming vary in their susceptibility to mountain pine beetle (MPB) outbreaks. This rating guide is designed to help land managers recognize stand conditions that are associated with low, medium, and high susceptibility (or risk) to MPB-caused losses. Similar guides have been prepared for other beetle-host associations (Amman et al. 1977, Lorio 1978, Safranyik et al. 1974, Schmid and Frye 1976). Using these guides, the land manager can compare stands and assign priority for thinning or other kinds of actions to those having the greatest risk of beetle-caused damage.

This rating guide is based on observations that provide insight into the kinds of stand conditions associated with MPB outbreaks (Sartwell and Stevens 1975) and the authors' experience with ponderosa pine and MPB in the Black Hills and elsewhere.

Three stand characteristics affect susceptibility to beetle attack: (1) stand structure, (2) average d.b.h. of the ponderosa pine component, and (3) stand density as expressed by average basal area per acre. Diameter growth rates, discussed by Sartwell and Stevens (1975), are closely correlated with stand density and are not considered separately.

Also, species composition is not included because relatively few acres of ponderosa pine are found in mixture with aspen, birch, or spruce, the other important tree species in the Black Hills.

This guide is designed to be applied to forest stands only; it will not work if applied to other kinds of units. A stand must be consistent in species composition, site quality, structure, tree density, and past treatment. Note that size (area) is not a stand characteristic.

### Stand Structure

The single-storied ponderosa pine stand is most susceptible to heavy MPB damage. It is most likely to become damaged first and also to suffer heavier losses (i.e., larger groups of killed trees and more of them). An arbitrary risk rating of 3 (table 1) has been assigned to such stands. Next in susceptibility is the two-storied stand, where attention is focused on the characteristics of the overstory trees. As tree size and density increase, these stands increase in susceptibility to approximate that of the even-aged stand. An overall risk of 2 is assigned to two-storied stands.

The multistoried stand is too small a component of the Black Hills forest to include in risk rating. As more acreage comes under management, such stands will presumably become a significant portion of the forest and can then be rated as experience with them develops.

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Table 1. --MPB risk classes for Black Hills ponderosa pine

	Risk classes		
	1 = low	2 = moderate	3 = high
Stand structure	—	2-storied	single-storied
Average stand d.b.h. (inches)	<6	6-10	>10
Stand density (square feet per acre)	<80	80-150	>150

### Mean Stand Diameter

As d.b.h. increases, risk of beetle outbreak also tends to increase, reaching a maximum when trees are around 12 inches d.b.h. and larger. Consequently, as mean stand diameter increases (i.e., the d.b.h. of the tree of average basal area), the risk of that stand being destroyed also increases. The risk is high (3), moderate (2), or low (1) when mean stand diameter, in trees at least 5 inches d.b.h., is more than 10 inches, 6 to 10 inches, or less than 6 inches, respectively. It is difficult to predict how much more susceptible a stand having a mean d.b.h. of 8 inches is than one having a mean d.b.h. of 12 inches or more. However, heavily damaged stands in the Black Hills are usually in the 10- to 12-inch d.b.h. range.

### Stand Density as Basal Area Per Acre

During the years a mountain pine beetle outbreak is building to its maximum destructive capability, the more dense the ponderosa pine stand is within a given mean diameter, the more susceptible it will be to severe losses. At maximum outbreak levels, this pattern is less evident because beetles must attack trees in a variety of conditions.

Stand density is arbitrarily ranked high (3), moderate (2), or low (1) when the basal area of ponderosa pine stems—in trees greater than 5 inches d.b.h.—is greater than 150 square feet per acre, 80 to 150 square feet per acre, or less than 80 square feet per acre.

### Using the Risk Plan

The user evaluates the characteristics of a stand and assigns to it the appropriate risk values shown in table 1.

First, determine whether the stand is single- or two-storied. Second, estimate stand density in trees 5 inches and larger and average stand d.b.h. Select risk values from table 1 and calculate risk by multiplying these together. Risk is then as follows:

Stand risk value	Risk rating
2-6	Low
8-12	Moderate
18-27	High

For example, consider a single-storied stand (risk 3) with a basal area of 180 square feet per acre (risk 3) and a mean d.b.h. of 11.2 inches (risk 3). The relative risk of such a stand is 27 (3 x 3 x 3). Such a stand is the most susceptible to MPB attack. If the average d.b.h. of the stand is 8 inches, the risk is 18 (3 x 3 x 2)—still high, but closer to moderate. The least susceptible stand, a two-storied thin stand of small trees, would rate 2 x 1 x 1, or at the bottom of the low risk category.

### Other Factors

The maximum size area to be given a single rating will probably be the main difficulty users experience with this plan. Some judgment in interpreting the guidelines in particular areas is necessary.

The key, as Schmid and Frye (1976) discuss in their risk-rating plan for spruce beetle, is to properly distinguish a stand. If the forest area in question does not fit the definition of a stand, particularly with respect to the three characteristics in this guide, ratings will probably be inaccurate.

Consider, for example, a 100-acre unit of ponderosa pine forest. Stand density over the entire unit may average 60 square feet per acre. If we used this average, it would work into our rating plan as "low risk." But if the overall area were made up of several 5- to 10-acre stands with densities approximately 200 square feet per acre and only widely scattered trees over the remainder, "low risk" would not properly categorize the entire area. The thickets are individual stands and would properly be classed "high risk."

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